Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

**Unit 2 (Biochemistry) – Drawing Connections between Topics and Concepts**

Ms. Ottolini, AP Biology

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| **Topic** | **Example Concept** | **Connections to Other Concepts in this Unit** |
| Atomic and Molecular Structure | A. The number of protons (positively charged subatomic particles) in the nucleus of an atom determines that atom’s electronegativity (its tendency to attract electrons). A strong positive charge in the nucleus (i.e. a lot of protons) results in a heightened ability to attract electrons (because opposite charges attract).  B. When oxygen (an atom with a high electronegativity) and hydrogen (an atom with a low electronegativity) form a covalent bond with one another, oxygen holds the two shared valence electrons more tightly than hydrogen, which results in oxygen having a partial negative charge and hydrogen having a partial positive charge. Because the electrons involved in the covalent bond are not shared equally between the two atoms, which results in “poles” of partial negative and positive charge, we call this bond a polar covalent bond. | A and B connect to H, J, and K |
| Environmental Matter Exchange | C. Organisms take in atoms of particular elements to use within the molecules that make up their tissues (i.e. the macromolecules).  D. Carbon and oxygen are used in carbohydrates, lipids, proteins, and nucleic acids. They are taken into organisms’ bodies through photosynthesis (when plants convert CO2 to glucose using the energy in sunlight) and when other organisms eat plants.  E. Hydrogen and oxygen are used in carbohydrates, lipids, proteins, and nucleic acids. They are taken into plants’ tissues by absorption via the roots. They are taken into animals’ tissues when animals drink water or eat plants and absorb the water in the plant tissues.  F. Nitrogen is used in proteins (in amino groups of amino acids) and nucleic acids (in nitrogen bases of nucleotides). It is taken into plants’ tissues by absorption of nitrate (NO3-) via the roots (after soil bacteria convert nitrogen gas from the air into a form usable by plants via nitrogen fixation and then nitrification). It is taken into animals’ tissues when animals eat plants and break down their proteins and nucleic acids to create their own proteins and nucleic acids.  G. Phosphorus is used in nucleic acids (in phosphate groups of nucleotides). Sulfur is used in proteins (in SOME “R groups” of amino acids containing sulfhydryl functional groups). Both of these elements are taken into plants’ tissues by absorption of soil phosphorus and sulfur via the roots. It is taken into animals’ tissues when animals eat plants and break down their proteins to create their own proteins. | C, D, E, F, and G connect to K |
| Properties of Water | H. Since the bonds between oxygen and hydrogen are polar covalent (see topic: atomic and molecular structure), the water molecule (H2O) is polar. The oxygen atom has a slight positive charge and the hydrogen atom has a slight negative charge. Water’s polarity enables it to act as a solvent for ionic and polar compounds. For this reason, organisms’ blood (which is mostly water) can dissolve sugars and waste products and carry them throughout the body.  J. Water’s polarity also enables it to form hydrogen bonds (weak attractions between the slightly positive hydrogen side of one water molecule and the slightly negative oxygen end of ANOTHER water molecule). Water’s ability to form hydrogen bonds enables water molecules to stick to each other (cohesion) and stick to other polar and charged substances (adhesion). A combination of cohesion and adhesion enables water to flow up a narrow tube (ex: a plant stem). Without transport of water from the roots to the leaves, plant tissues high up near the leaves would not receive water and would not be able to undergo photosynthesis (since water is one of the reactants for photosynthesis). Water’s ability to form hydrogen bonds also gives it a high specific heat (i.e. it takes a lot of heat energy to change the temperature of water, since hydrogen bonds between water molecules must be broken before it changes temperature). Since organisms’ cells are made mostly of water, organisms’ cells and bodies resist changes in temperature. Therefore, their bodies can resist changes in temperature caused by changes in the temperature of the outside environment. Organisms must maintain a fairly constant body temperature so that their enzymes will function correctly (see topic: enzymes). | H and J connect to A,B, E, and K |
| Macromolecules | http://www.freethought-forum.com/images/anatomy2/phospholipid.gifhttp://withfriendship.com/images/g/30850/Phospholipid-picture.jpgK. The atoms (i.e. carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur) and functional groups (i.e. hydroxyl, carbonyl, carboxyl, animo, sulfhydrul, phosphate, and methyl) found in the major molecules (i.e. carbohydrates, lipids, proteins, and nucleic acids) that make up cell structures determine the structure and function of those major molecules. For example, hydroxyl groups found on sugars (ex: monosaccharides like glucose) make them polar and able to dissolve in water. For this reason, they can be carried easily in the bloodstream (which is mostly water). Another example of functional groups causing certain properties in macromolecules involves the phosphate group found in the head of phospholipid molecules and the methyl groups found in the two fatty acid “tails” of phospholipid molecules.  -The phosphate group within a phospholipid head has a negative charge. Because it is charged, the head region is attracted to water (a polar molecule with slight charges at opposite ends).  -The methyl groups (-CH3) in the fatty acid tails are nonpolar because carbon and hydrogen have similar electronegativities (neither atom holds electrons more tightly than the other, so neither atom has a slight charge when carbon and hydrogen form a covalent bond). Therefore the fatty acid tails are nonpolar because they are made of mostly carbon and hydrogen atoms.  -Because of their polar (hydrophilic) head regions and nonpolar (hydrophobic) tail regions, phospholipid molecules arrange themselves in a double layer to form the basic structure of a cell membrane (the phospholipid bilayer). The phospholipids arrange themselves with the hydrophilic (water loving) heads facing the water on the inside and the outside of the cell and the hydrophobic (water fearing) tails isolating themselves on the inside of the membrane. Because any molecule entering the cell by simple diffusion across the lipid bilayer must pass through the hydrophobic tail region, only small nonpolar particles can pass through. In this way, the cell prevents harmful large, polar, or charged molecules from entering the cell. For example, viruses (which are made of large, charged proteins and nucleic acids) cannot enter a human cell without a special adaptation (ex: a structure shaped like an injection needle to puncture the cell membrane and deliver the viruses’ genetic material).  http://www.biologycorner.com/resources/lipidbilayer.gifhttp://academic.brooklyn.cuny.edu/biology/bio4fv/page/lipos.gif | K relates to A, B, C, D, E, F, G, H, J, L, and N |
| Enzymes | L. Enzymes are a special type of protein molecule that are used to speed up chemical reactions. Each enzyme has an active site that contains functional groups that allow it to bind a particular substrate with “complementary” functional groups. (For example a positively charged amino group [NH3+] that has received an extra H+ within the active site will be attracted to a negatively charged carboxyl group [COO-] that has given up an H+ within a substrate.)  M. The enzyme and substrate have an “induced fit.” In other words, once the substrate binds to the enzyme’s active site, the active site changes shape to better fit the substrate. For an anabolic (building) reaction, the change in shape of the active site will push two substrates closer together in space and enable them to form a chemical bond that joins them together. For a catabolic (breaking) reaction, the change in shape of the active site will place stress on the chemical bonds within the single substrate and cause them to break, resulting in multiple products (pieces of the original substrate molecule).  http://bio1151.nicerweb.com/Locked/media/ch05/05_16EnzymeCatalyticCycle.jpgN. Enzymes facilitate and improve the efficiency of MANY reactions within the cell. An example of a reaction facilitated by an enzyme is the breakdown of a disaccharide (sucrose) into two monosaccharides (glucose and fructose) through the process of hydrolysis and the use of the enzyme sucrase. | L and N relate to K |